SFB 805 | B4 | FP3

Integration of functional materials

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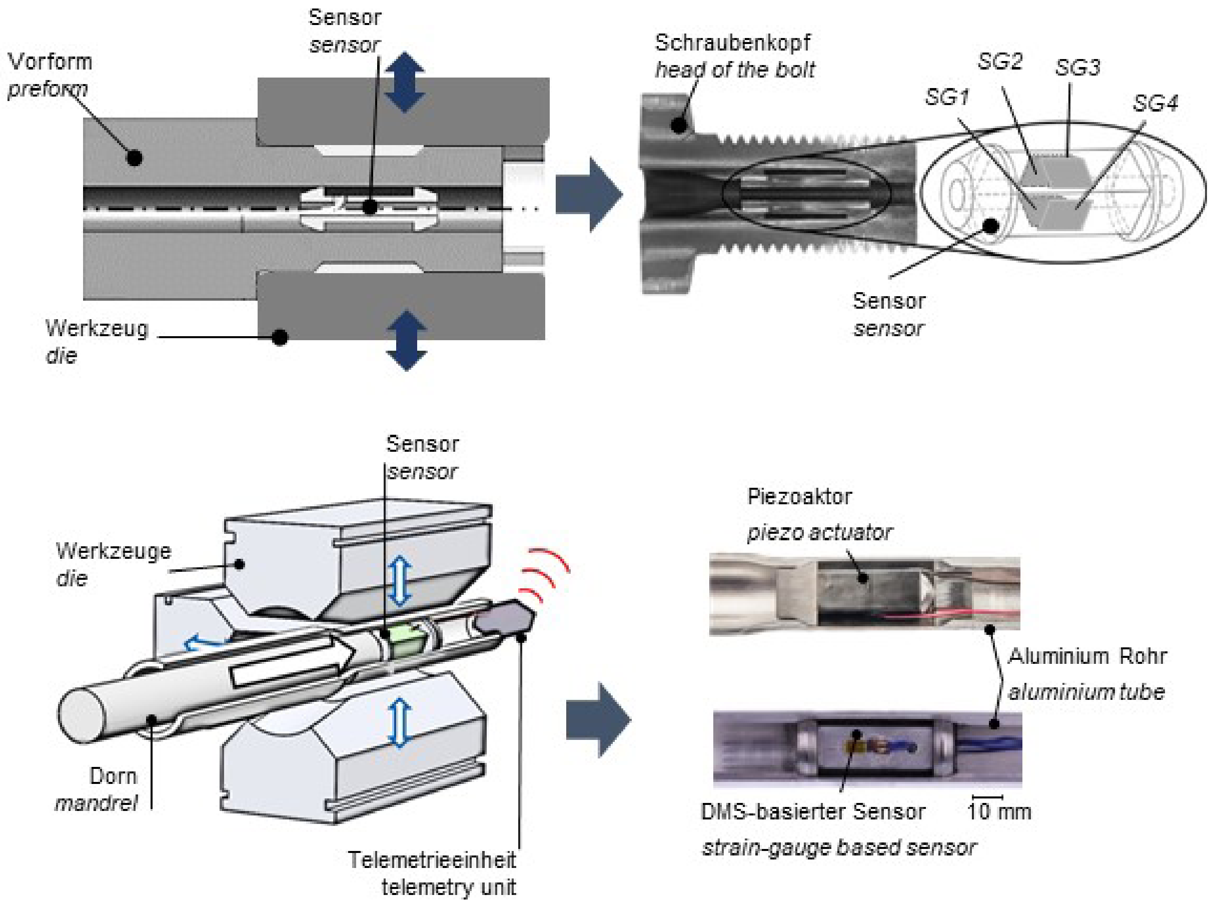
Abstract

In the third project phase, methods for developing and manufacturing axially symmetrical load-bearing structures with forming integrated force sensors were established and validated. By means of a simultaneous joining and forming process, sensitive functional materials are pre-tensioned integrated into the formed structure. In addition, an optical measurement concept for multiaxial force/torque measurement was developed.

Project description

Uncertainty in load-bearing structures of the mechanical engineering occurs in the design, manufacturing and use phase. In order to master this uncertainty, one approach is to equip mechanical structures with additional functional elements such as sensors and actuators as well as the required periphery. In order to enable a broad application of function-integrated machine elements, manufacturing processes have to be optimized for a cost-efficient and mass production.

Within the Collaborative Research Center SFB 80, functional elements such as sensors or piezo actuators are damage-free integrated into load-bearing structures within the scope of subproject B4. The incremental cold forging process rotary swaging is used, in which the work-piece is formed in many small increments. Four oscillating tools reduce the diameter of a tube-shaped workpiece through alternating tool movements. A flexible outer con-tour of the created function-integrated structures also re-quires adapted process control and the use of mandrels.



[1] Joining processes and created smart structures with integrated functional materials, above recess rotary swaging, and below infeed rotary swaging

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Results

Within the third project phase, methods and process designs were developed for the integration of functional materials into fasteners based on recess rotary swaging and into long tubular structures based on recess and in-feed rotary swaging. With such sensory structures it is possible to monitor loads in the joining elements and within structures. As a result, they can be considered not only as key elements for safety related questions, but also as enablers for the reliable and effort minimized acquisition of additional information for process analysis and control.

The sensory fasteners and load-bearing structures (cf. Figure 1) consist of a mechanical load-bearing structure in which an actuator or spring element with applied elementary sensors is integrated by rotary swaging. During the production of the sensory structures and fasteners, the transducers are inserted into the structure under preload.

By in-situ measurement of the actual load condition and the data transmission by telemetry units (cf. Figure 1), the joining process itself was monitored and controlled. For this purpose, control approaches were developed to ensure a damage-free integration of the sensible functional materials and on the other hand to achieve reproducibility in the preload.

Acknowledgement

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